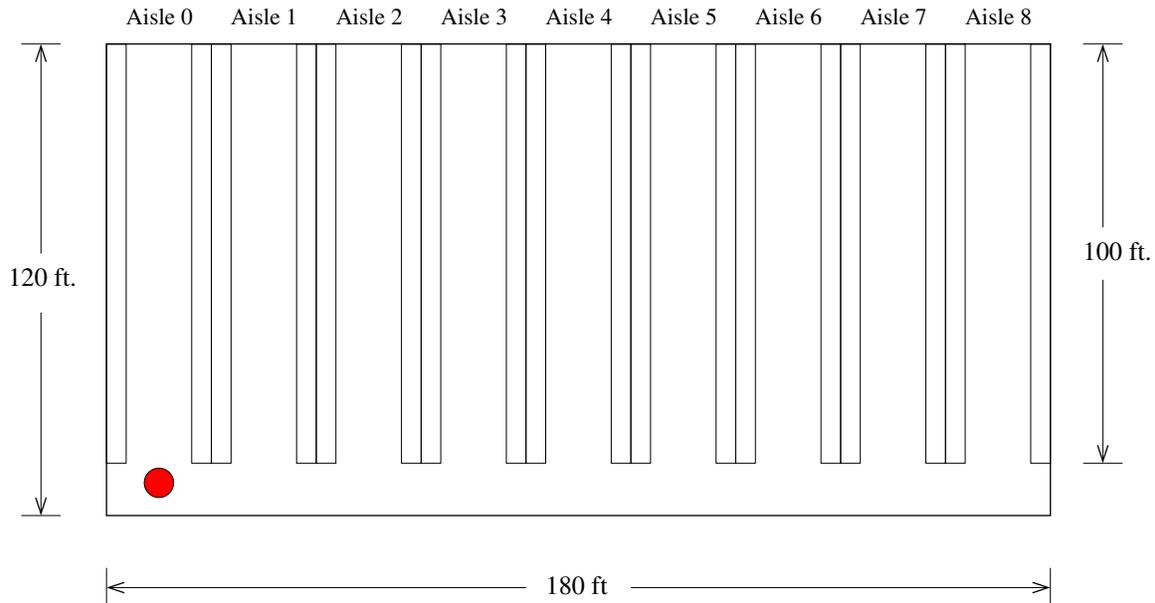


For this lab, we will be simulating the operation of a small parts warehouse. The 21,600 square foot warehouse consists of 9 isles of shelves where each isle is 100 feet long, The floor layout is illustrated below:



A collector robot is programmed to process requests for items from the shelves (i.e., fetch items from the shelves). Each request consists of a aisle number (in the range 0 to 8) and a bin number found on that aisle. Each bin is one foot wide, so the bin numbers are labeled 0, 1, 2, 3, ..., 99. Each request is handled in the order it is received. On receiving a request, the robot travels from its present location to the location of the bin where the required item is found.¹ Upon arriving at the correct bin, the robot requires 10 seconds pick up an item from the appropriate bin. The robot can travel along any aisle at the speed of 5 feet per second. To simplify our simulation, we will ignore the time taken by the robot to accelerate to its maximum speed of 5 feet per second and the corresponding time to decelerate to a halt. We essentially presume the robot can start and stop instantaneously.

Our robot can collect up to 20 items at which point it must return to the red circle to off-load the collected items to a shipping robot. The 20 items are off-loaded to the shipping robot in 30 seconds. Assume consecutive requests are statistically independent, and uniformly distributed over the aisle and bin numbers. I.e., any aisle or bin is equally likely.

Our Goal: Simulate the operation of the warehouse robot and answer two questions:

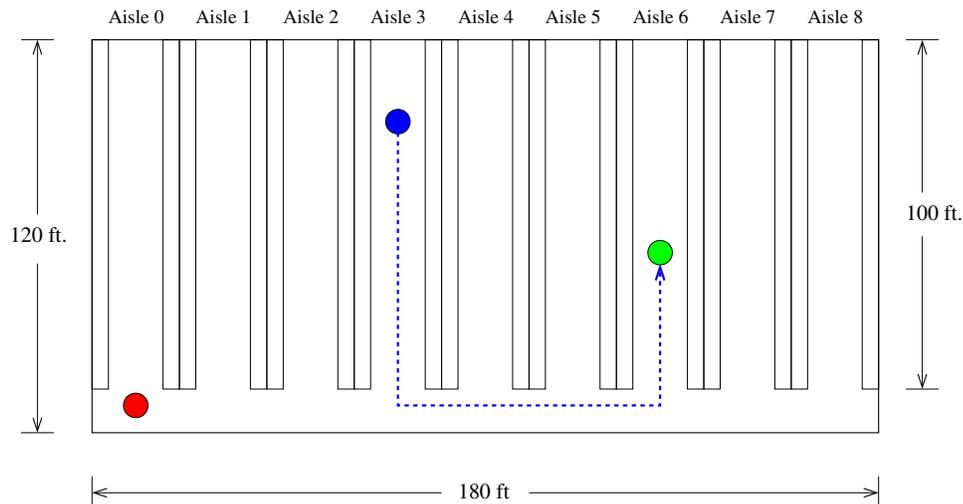
1. What is the average distance the robot travels for each selected item?
2. What is the average number of items delivered to the shipping robot per hour?

¹The robot would obviously benefit from route planning, but the programmers say they haven't got that working yet. Until route planning software is ready, the robot picks the items in the order in which the requests are received.

Robot Movement

- Distances and times are easily calculated if we impose a coordinate system on our warehouse, and choose the red circle as the origin $(0, 0)$. Initially, the robot is at the origin.
- The front travel-way is 20 feet wide as shown in the diagram. We will assume that whenever the robot uses the travel-way it positions itself in the center of the travel-way. Observe that there is a distance of 10 feet from the center of the travel-way to bin 0 on any aisle. This distance must be included in the calculation of the robot's travel.
- Whenever a request is processed where the destination aisle matches the current aisle, the distance traveled is the absolute value of the difference between the bin numbers.
- Whenever a request is processed where the destination aisle is different from the current aisle, the distance traveled is the sum of:
 - the distance from the current bin to the center of the travel-way, **plus**
 - the distance along the travel-way (20 ft per aisle), **plus**
 - the distance from the center of the the travel-way to the destination bin.

An example pathway from the blue dot on aisle 3 to the green dot on aisle 6 is illustrated below:



Simulation

- Simulate 1000 requests. Each request is a random location within the warehouse.
- For each 20th request, remember to include the distance and time needed to return to the red circle for off-loading.
- Keep separate running totals for distance and time.
- Print the average distance traveled as the total distance divided by 1000.
- Use the total time to compute the average number of items delivered to the shipping robot per hour.

Turn in:

- Keep all your work in a sub-directory named **Lab2**
- Your Java source code file should be named **robot.java**
- To upload:

Change to your home directory. Create a file named “lab2.tar” using the command:

```
tar cf lab2.tar Lab2
```

Upload the file “lab2.tar” using **sftp** to your account on telesto.